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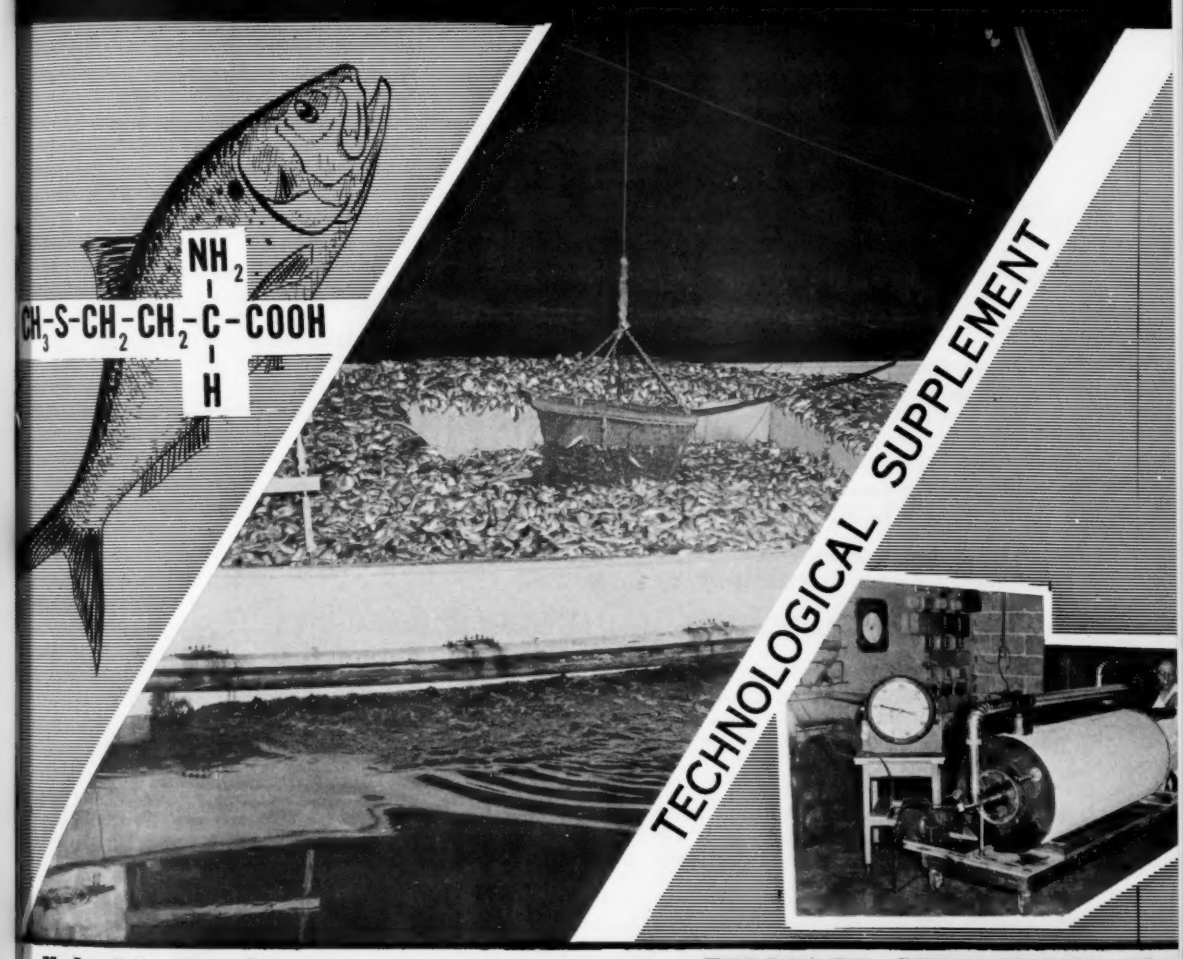
COMMERCIAL FISHERIES REVIEW



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COMMERCIAL FISHERIES REVIEW

A review of developments and news of the fishery industries
prepared in the BUREAU OF COMMERCIAL FISHERIES.

Joseph Pileggi, Editor
H. M. Bearse, Assistant Editor

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COVER: Menhaden are customarily processed into fish meal and oil. The quality of the meal, an important part of poultry rations, is largely determined by its content of amino acids, the building blocks of animal tissue. The structural formula of methionine, a sulfur-containing amino acid, is illustrated.

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COMMERCIAL FISHERIES REVIEW

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PROGRESS ON INVESTIGATIONS OF NUTRITIONAL VALUE OF FISH-MEAL PROTEIN

By C. R. Grau,* L. E. Ousterhout,* B. C. Lundholm,** and N. L. Karrick***

ABSTRACT

The objectives of the investigations reported here were to determine the causes of variability of protein quality in fish meal.

BACKGROUND

A study of the nutritional value of fish meal was begun in 1955 when funds were made available by the Saltonstall-Kennedy Act. As a part of this study, a joint investigation on nutritional value of fish-meal protein was started by the Poultry Husbandry Department, University of California, and the Seattle Fishery Technological Laboratory of the U. S. Bureau of Commercial Fisheries. The objectives of this investigation were (1) to survey the variability of protein quality in commercial fish meals and (2) to determine the causes for the variation.

A detailed report of the survey is given in another paper in this supplement.

The present paper reports progress on the investigation of the causes of the variability. These investigations include studies on (1) effect of raw material and its condition, (2) effect of storage, (3) effect of processing conditions, and (4) development of chick assays to measure "available" amino acids.

EFFECT OF RAW MATERIAL AND ITS CONDITION

Results of preliminary studies on the effect of raw material were described by Grau, Barnes, Karrick, and McKee (1956). These studies were made on tuna. Tests on spoiled and unspoiled, cooked and uncooked material also were made using other species of fish. In each test, meal dried from cooked fish that subsequently was allowed to spoil did not permit growth of chicks. On the other hand, meal prepared (1) from cooked fish that was unspoiled or (2) from raw fish--whether unspoiled or spoiled--permitted good growth.

Attempts now are being made to determine the cause of the detrimental effect of material that is cooked and then spoiled. Studies are being made on extracts of the material, and bacteriological investigations are being started under the supervision of Dr. Reese Vaughn of the Food Technology Department at the University of California.

EFFECT OF STORAGE

A menhaden meal was prepared in a steam-jacketed drier at the Seattle Fishery Technological Laboratory. It is being stored both at room temperature and at

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-20° F. in atmospheres both of air and of nitrogen. After 6 months of storage, the quality of the protein had not deteriorated in meal stored under any of these conditions. The meal will be tested again, however, after longer periods of storage. Storage studies also are being made on commercially-prepared meals.

EFFECT OF PROCESSING CONDITIONS

Studies are under way on the effect of processing conditions on the nutritional quality of fish meals. Meals are prepared in the pilot-plant drier described by McKee and Karrick (1956). Initially, meals were prepared under extreme conditions of cooking, pressing, and drying. Meals dried at 395° F. for 3 hours, when fed as the only source of protein, did not permit chicks to grow.

Time and temperature relationships on the effect of the nutritional value of the protein are being studied. In preliminary studies on the effects of length of time a meal is subjected to a high temperature, one series of meals was dried at 390° F. for time intervals ranging from 15 minutes to 3 hours. In the studies on the effects of temperature, another series of meals was dried for one-half hour at temperature increments of 25° F., ranging from 200° F. to 390° F. Nutritional tests are presently being made on these two series.

Meal dried for a long period of time has a low moisture content. Poor quality of the protein in these meals may be due to (1) damage by heat or (2) the low moisture content. Consequently, an experiment was run to determine whether a meal of low moisture content prepared at relatively low temperatures affected the nutritional value. In this experiment, a meal sample was dried to 10-percent moisture in the drier at 270° F. It then was dried under vacuum at 90° F. to 1.9-percent moisture content. No significant decrease in nutritional value was noted.

DEVELOPMENT OF CHICK ASSAYS FOR "AVAILABLE" AMINO ACIDS

The method that has been used at the University of California to determine the nutritional value of the meals measures the over-all protein value and amino acid balance of the meal. This procedure, however, does not indicate whether an excess of any amino acid exists. Such knowledge is of importance if the fish meal is being used as a supplement for other proteins. Lysine and methionine, for example, often are deficient in the vegetable proteins that furnish most of the protein in practical poultry diets, and an excess of these amino acids in a fish meal therefore improves its value as a supplement. Consequently, work was started to develop chick assays that would determine the amounts of individual amino acids available to the chick. These assays will help to pinpoint differences among meals and will give a quantitative measure of the difference.

The assay now has been found to be successful for lysine, methionine, arginine, threonine, and combined methionine and cystine. It shows promise for histidine, phenylalanine, tryptophane, and combined phenylalanine and tyrosine. The assays are being refined at present. A paper describing the assays has been prepared.

SUMMARY

The objectives of the investigation reported here were to survey the variability of protein quality in commercial fish meals and to determine the causes for these variations. A detailed report of the survey is published elsewhere in this supplement. The research into causes of variations in quality reported in the present paper includes studies on (1) effects of raw material, (2) effects of storage, (3) effects of processing conditions, and (4) development of a chick assay to measure "available" amino acids.

Conclusions have not been reached on the relative importance of any of the causes of variation. The condition of the material used to prepare the meal, however, can cause decreased or even negative growth of the chicks. Studies are being made to determine the cause of this phenomenon.

The presence and availability of individual amino acids are being studied. An important development has been the establishment of an assay to measure in a meal the amounts of individual amino acids that are available to chicks.

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OLD FISH BOXES--BACTERIA UNLIMITED!!

"Bacteria in Fish Boxes" was the title of a report made by R. Spencer in 1955 (The Fishing News, December 30, 1955, p. 5). The data he presented should have frightened every handler of fresh fish. Old fish boxes were loaded with bacteria--the worst enemy of good quality in fresh fish.

The old fish boxes he tested were found to have 450,000,000 bacteria per square inch. After these boxes were cleaned by hosing with water, there were still 175,000,000 (equal to the population of the United States) bacteria per square inch. A strong "chlorine" bactericide, with 1 part of free chlorine per 1,000 parts of water, was not very effective. Even with plenty of scrubbing, these "chlorine" compounds left over 1,000,000 bacteria per square inch, and then after standing 48 hours these bacteria were off on another growing rampage. Bacteria counts around 250,000 per square inch were obtained on old boxes even after thoroughly hosing with water and then steaming for 60 minutes.

Wooden boxes, used only once to ship fish, were well inoculated with bacteria--20,000,000 per square inch. This number was reduced to 2,000,000 by washing with plenty of water. A chlorine bactericide or steaming would lower the number another 90 percent. Even then, there would be a multitude of "seeds" to start rapid spoilage in otherwise good fish.

What about new boxes? The unused, new boxes showed only 70 bacteria per square inch (and these bacteria probably were not mainly spoilage-producing bacteria). Thus a once-used box--remember, used only once--is several thousand times worse than a new box. An old box, even after it is washed well with a hose, has a few million times as many bacteria as a new box. (N. F. I. Flashes, No. 595, December 5, 1958.)

STUDIES ON EFFECT OF PROCESSING AND STORAGE ON THE CONTENT OF UNKNOWN GROWTH FACTORS IN FISH MEAL[1/]

By H. R. Bird*

ABSTRACT

Within the limits of precision of the assay, the methods of processing and of storage used in the present study had no measurable effect on the relative content of growth factors in fish meal.

BACKGROUND

During 1955 and 1956, more than 20 samples of commercial and experimental fish meals, including 8 commercial menhaden meals, were assayed for unknown growth factors by feeding the meals to chicks according to the procedure of Barnett and Bird (1956). In each assay, a standard sample of fish solubles was fed at several levels. The standard sample was assigned a potency of ten. The potencies of all of the fish-meal samples, when compared with the standard sample of fish solubles, ranged from 2.5 to 13.8. The comparative potencies of the eight commercial menhaden meals were 13.8, 11.8, 9.5, 5.4, 5.3, 3.0, 2.7, and 2.7. Attempts to relate this wide variation to known differences in origin, processing, or storage of the meals were unsuccessful.

The variation in growth-factor content of the meals was great enough to be of practical importance, so it was desirable to study systematically the variables that might influence growth-factor content.

EXPERIMENTAL AND RESULTS

Two special samples of menhaden meal were set aside for storage studies. Results obtained thus far are given in table 1.

Table 1 - Effect of Storage on the Relative Unknown-Growth-Factor Potency of Two Menhaden Meals

Meal Sample	Storage Conditions			Relative Unknown-Growth-Factor Potency
	Kind of Atmosphere	Temperature	Time	
Number		Degrees F.	Days	Units Per Gram
GF 600	Air	Room	0	6.2-14.7
	Air	Room	44	5.5- 7.0
	Air	Room	210	5.1- 6.4
	Nitrogen	Room	210	8.7-13.6
	Air	-20	210	4.3- 8.1
	Nitrogen	-20	210	8.1- 8.4
GF 601	Air	Room	0	5
	Air	Room	20	6.7- 8.2
	Air	Room	42	5.8- 7.1

A series of tuna meals was processed experimentally, and the individual meals were exposed to different temperatures for different times during cooking and drying. The results are given in table 2.

DISCUSSION

Storage up to 7 months did not cause measurable variations in the experimental meals (table 1) and thus did not help to explain the previously observed variations

1/This research was performed under a collaborative agreement between the University of Wisconsin and the U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries.

* Chairman, Department of Poultry Husbandry, University of Wisconsin, Madison, Wis.

in commercial meals. Unfortunately, the initial assay of sample G. F. 600 yielded a wide range of values, including some that were questionably high. The relatively consistent values obtained in subsequent assays, for example, cast doubt on the value of 14.7 obtained in the first assay.

A real decrease in potency during the first 44 days of storage is unlikely, especially since no such decrease was measurable in the case of sample G. F. 601. Likewise, it cannot be said that temperature or exposure to air influenced potency during storage of G. F. 600 for 7 months. The sample kept under nitrogen at -20° F. showed slightly greater potency than did the one stored in air at room temperature, but no importance can be attached to such small differences in an assay as variable as this one.

Unfortunately, the assays of the meals subjected to different processing conditions also showed considerable variability from one test to another. It does not appear that any of the treatments caused a measurable decrease in growth-factor potency.

Table 2 - Effect of Processing Conditions on the Relative Unknown-Growth-Factor Potency of Several Tuna Meals Prepared from the Same Raw Material

Meal Sample	Processing Conditions			Relative Unknown-Growth-Factor Potency		
	Cooking	Drying				
	Time 1/	Time	Temperature	Test 1	Test 2	Test 3
Number	Hours	Hours	Degrees F.	Units/g.	Units/g.	Units/g.
628	0.5	0.5	270	9.1-13.3	4.5- 4.6	4.2-5.2
629	0.5	0.25	390	8.3-17.8	8.4-11.3	3.4-7.8
630	0.5	5	105	10.2-17.0	4.2- 6.9	7.0
631	0.5	3	390	2.4- 9.1	5.4-16.5	3.5-4.9
632	3	0.5	270	-	14.4	7.5-7.6

1/ A batch process at 8 pounds pressure.

If variability of growth-factor potency is not related to storage time or temperature and time of processing, one must next consider variations in raw material before processing. Meals made from a number of species of fish have already been tested without showing any marked or consistent variation due to species. There remains the possibility that holding time and conditions before processing might be important.

Although the method of assay used is as precise as present knowledge will permit, the method obviously will not reveal small differences in potency. In fact, with results as variable as those obtained in the processing study, the growth-factor potency would have to be almost completely destroyed before the assay would reveal, with certainty, a decrease in potency. It might be pointed out that the development of a precise method of assay for unknown growth factors is difficult. The experience gained in the present studies may eventually contribute to the design of an assay with greater precision.

SUMMARY

Growth-factor potency of menhaden meals was not measurably decreased by storage for 7 months in air at room temperature. The potency of tuna meals was not measurably decreased by any of the heat treatments tried during cooking and drying. The assay for growth factors, being quite variable, does not reveal small differences in potency, however, so we cannot say that these factors had no effect.

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PROTEIN ANALYSIS OF SHRIMP-WASTE MEAL

By Russel L. Brown*

ABSTRACT

A method for the analysis of chitin nitrogen in shrimp meals and a procedure for correcting the crude protein fraction for the apparent protein contributed by chitin nitrogen is given.

INTRODUCTION

Fish meal is characterized for animal-feeding purposes by a proximate analysis for protein, oil, moisture, and ash. In shellfish meals, this analysis gives erroneously high results if no correction is made for the apparent protein contributed by chitin, an N-acetylated glucosamine polysaccharide. This shortcoming has been recognized by South African workers (Black and Schwartz 1950), who have devised a method for the estimation of chitin and chitin nitrogen.

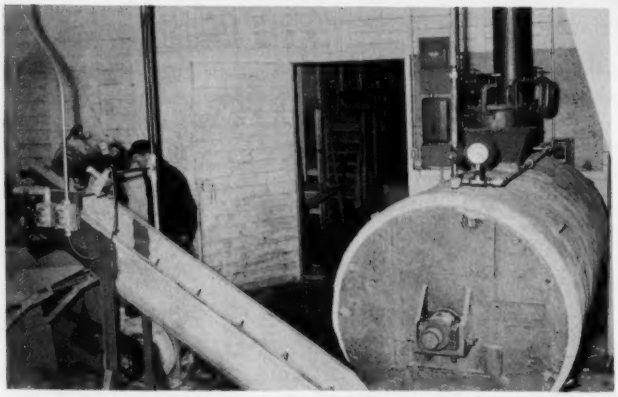

Fig 1 - A rotary steam-jacketed batch drier used for the preparation of meal from shrimp waste. The drier is fitted with a water-injection vacuum pump (not shown).

Since the protein fraction is of great interest to both the buyer and the producer of shrimp-waste meal, a more reliable estimate of the protein was needed. In the use of the Kjeldahl method for determining the protein fraction, a figure is obtained that includes not only protein nitrogen but also chitin nitrogen. Attempting to solve this problem, we turned to the South African work. Upon investigation, we found that this method involved filtration and that, possibly owing to fats in the meal, the filtration was very laborious and sometimes impossible to carry out. A variety of filtration techniques such as using different grades of filter paper, filtercel, butcher's linen, and filter-paper pulp were studied, but all proved to be impractical. A review of the literature therefore was undertaken, aimed at finding a more satisfactory analysis for chitin nitrogen.

Table 1 - Crude Protein in Shrimp-Waste Meal Corrected for Apparent Protein Contributed by Chitin

Sample	Protein as Calculated from Kjeldahl Nitrogen	Apparent Crude Protein Contributed by Chitin Nitrogen			Average	Corrected Crude Protein
		Replicate				
		1	2	3		
	(Percent)					
Meal A	45.70	3.34	3.33	3.27	3.31	42.39
Meal B	53.85	3.24	3.30	3.21	3.25	50.60
Meal C	54.85	3.14	3.06	3.07	3.09	51.76
Meal D	51.79	3.21	3.20	3.23	3.21	48.58
Meal E	53.58	3.55	3.49	3.51	3.52	50.06

The literature indicated that in almost all cases, the major problem involved in this analysis was filtration. An investigation of a procedure for the isolation of

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chitin (Horowitz, Roseman, and Blumenthal 1957) showed that if the formic acid digestion used in this method was preceded by a modified acetone extraction (Dam-

Table 2 - Proximate Analysis of Shrimp-Waste Meals

Sample	Corrected Crude Protein	Oil	Moisture	Ash	Part of Meal Not Accounted For
	(Percent)				
Meal A	42.39	8.83	19.56	20.80	8.42
Meal B	50.60	15.33	5.54	20.66	7.87
Meal C	51.76	13.09	5.21	21.15	8.79
Meal D	48.58	13.15	8.07	21.99	8.21
Meal E	50.06	14.20	2.28	23.52	9.94

bergs 1956) and that if it then was combined with the caustic digestion used by Black and Schwartz, filtration could be replaced, for the most part, by centrifugation. This combination finally was found to be satisfactory.

The principle of this method, in brief, is as follows: (1) acetone extracts the fat, (2) formic acid decalcifies the meal and extracts colored impurities and part of the protein, and (3) sodium hydroxide extracts the remainder of the protein, leaving only chitin and any silica present in the sample.

PURPOSE

The purpose of this paper is to describe this procedure and to report the results obtained by use of it.

PROCEDURE

The determination of the amount of crude protein in shrimp meal, corrected for the amount of apparent protein contributed by chitin nitrogen, is as follows:

1. Weigh a 5-gram sample of meal into a 250-milliliter centrifuge bottle fitted with a reflux condenser.

2. Add 100 milliliters of acetone, reflux for 45 minutes using a boiling water bath, centrifuge for 20 minutes at 2,000 r.p.m., and discard the supernatant.

3. Add 100 milliliters of a 70-percent acetone-water mixture, shake well, centrifuge for 20 minutes at 2,000 r.p.m., and discard the supernatant.

4. Add 100 milliliters of 90-percent formic acid, stopper, shake for 18 hours, centrifuge for 15 minutes at 2,000 r.p.m., and discard the supernatant.

5. Wash the residue with acetone, centrifuge for 20 minutes at 2,000 r.p.m., and discard the supernatant.

6. Repeat step 5, substituting 70-percent acetone-water for the acetone.

7. Add 100 milliliters of 5-percent (w/v) sodium hydroxide, reflux for 90 minutes on a steam bath, filter with suction through a sintered glass funnel (coarse porosity), and discard the filtrate.

8. Wash the residue with boiling water once, discard the filtrate, transfer the residue quantitatively to a 250 milliliter Kjeldahl flask with the smallest possible amount of water, evaporate until less than 5 milliliters of water remains, and proceed with the Kjeldahl determination in the usual manner, but digesting for 6 hours.

9. Calculate the percent protein from the amount of nitrogen determined, employing the usual factor of 6.25. (The figure obtained by this method is the percentage of apparent protein contributed by chitin nitrogen.)

10. Subtract the figure obtained in step 9 from the percent of crude protein obtained by the regular Kjeldahl determination.

RESULTS AND DISCUSSION

Samples of commercial shrimp-waste meals were obtained, and by the use of the procedure just described, the true amount of crude protein in the meals was estimated, with results reported in table 1. The data for the proximate analyses, using these estimated values, are given in table 2.

Chitin isolated by this method was dried and added to a commercial meal to test the recovery. These results indicated a 109-percent recovery of chitin.

The 8 to 10 percent of the meal left unaccounted for by the proximate analysis is probably due, for the most part, to the chitin fraction itself. Although a method for estimating this fraction might be derived, no attempts were made to do so because some deacetylation of the N-acetylglucosamine fragments reportedly occurs (Horowitz, Roseman, and Blumenthal 1957) during the digestion steps.

SUMMARY AND CONCLUSIONS

As the result of production of commercial shrimp-waste meal in Alaska, a method of analysis for chitin nitrogen was needed that would permit a reliable estimate of the true crude protein fraction of such meals.

The present paper reports a method involving (1) extraction with acetone to remove fats, (2) digestion with formic acid to decalcify the meal and extract colored impurities and part of the protein, (3) digestion with sodium hydroxide to extract the remainder of the protein, and (4) determination of Kjeldahl nitrogen. Use of centrifugation eliminates many of the troublesome filtrations required in earlier methods.

The results obtained by the present method are sufficiently reproducible to favor its adoption for use in proximate analyses of shrimp-waste meal.

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RAT-FEEDING STUDIES TO DETERMINE NUTRITIVE VALUE OF FISH SCALE PROTEIN [1/]

By C. R. Fellers,* N. I. Lemack,* L. R. Parkinson,* and G. E. Livingston*

ABSTRACT

The nutritive value of both raw ground and hydrolyzed ocean perch and herring scales was studied by means of three rat-feeding experiments. It was determined that scales may not be used as the sole source of protein in the diet, but that they may be used to supplement part of the protein with no loss of nutritive value.

INTRODUCTION

Thousands of tons of fish scales have had to be disposed of as nonutilizable waste during the past several years, since fillets have now replaced round and dressed fish in sales volume. Harbors near fish plants normally allow for a commercially-inexpensive disposal area for scales, but unless tidal flows are strong pollution may result.

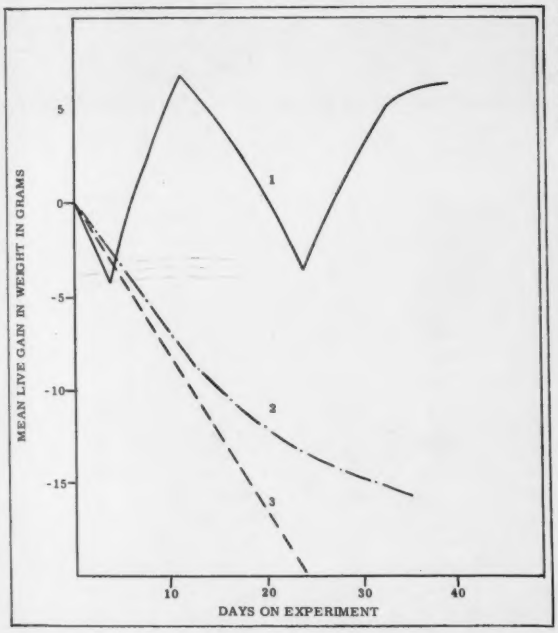

Fig. 1 - Mean daily weight of groups of rats fed diets containing protein from casein (1), raw ground ocean perch scales (2), and a pepsin hydrolysate of these scales (3).

This study has been conducted to determine whether ocean perch (Sebastes marinus) scales can be included to advantage with press cake in the commercial production of fish meal. The feasibility of this possible method of solving the scale-disposal problem requires the determination of the biological values of the protein of the fish meal alone and in various combinations with ocean perch-scale protein.

Fellers et al (1957) reported a method suitable for preparing scale hydrolysates for use in animal-feeding tests, since there is some reluctance on the part of the fish-meal manufacturers to handle the abrasive raw scales due to the poor grinding properties of the scales. This paper, therefore, includes data on the biological values of the protein of pepsin-hydrolyzed scales and of raw scales.

EXPERIMENTAL AND RESULTS

In the first rat-feeding study, the biological value was determined of diets containing the nitrogen compounds in raw ocean perch scales, a hydrolysate from these

1/The research reported in this paper was conducted by the University of Massachusetts under a contract with the U. S. Bureau of Commercial Fisheries. It was financed by funds made available under Public Law 466, 83rd Congress, approved July 1, 1954, generally termed the Saltonstall-Kennedy Act. The research was under the general supervision of the staff of the Fishery Technological Laboratory, East Boston, Mass. They also aided the contractor in obtaining supplies of fish scales as needed throughout the study. This article was prepared by Dr. Donald G. Snyder, Biochemist, Fishery Technological Laboratory, College Park, Md., from progress reports submitted by the contractor to the U. S. Fish and Wildlife Service.

* Researcher, University of Massachusetts.

scales, and casein. The method of assay used was one developed by Mitchell and Beadles (1930).

Three groups of 14 post-weaning albino rats each were fed similar isocaloric diets, otherwise nutritionally complete but containing as the only source of protein the casein, scale hydrolysate, or raw scales at levels of 9-percent protein (or equivalents) in the diet. The hydrolysate and raw scales contained 34 and 49 percent of crude protein (N x 6.25), respectively. The feeding period was 6 weeks.

Fig. 2 - Crude protein content of fish scales is determined by Macro-kjeldahl procedure.

The rats of the groups fed the hydrolysate and raw-scale diets lost weight, and nearly all died before the conclusion of the feeding study (table 1, fig. 1). The rats fed the hydrolysate diet lost more weight and died sooner, however, than did those fed the raw-scale diet. It therefore can be concluded (1) that the scale hydrolysate and raw scales alone as the source of protein in another-

Table 1 - Periodic Mean Grams Gain or Loss in Weight of Groups of Rats Fed Diets Containing 9-Percent Protein from Casein, Ocean Perch Scales, or Ocean Perch-Scale Hydrolysate

Time on Experiment	Diet Designation		
	Casein	Raw Ocean Perch Scales	Ocean Perch Scale Hydrolysate
Days	(Grams)		
2	- 6.7	- 7.3	- 5.0
3	-10.0	-10.0	- 6.0
4	- 4.4	- 6.1	- 6.8
5	- 3.0	- 6.0	- 9.0
6	4.5	- 7.5	- 6.0
7	1.0	- 8.0	-11.0
8	6.3	- 7.5	- 8.0
10	- 2.6	- 7.8	- 6.8
11	7.0	- 6.0	-15.0
12	- 1.0	- 8.3	-13.4
13	3.7	- 8.8	- 6.3
14	2.5	- 7.7	-10.0
15	4.7	-11.0	-16.7
16	12.0	- 9.0	-12.0
17	3.0	-10.1	-10.5
19	- 0.5	-19.5	-13.5
20	3.0	-13.0	-
21	0.8	-12.0	- 9.2
24	- 4.0	-18.0	-
28	- 1.0	-13.0	-
30	3.2	-12.2	-
34	6.0	-14.0	-
36	5.0	-13.0	-
42	7.0	-11.5	-

wise nutritionally-complete diet cannot support growth or maintain life of young rats and (2) that raw scales are utilized somewhat better than are the hydrolyzed scales. Either the hydrolysate contains less available nitrogen compounds, or a toxic factor was introduced during the enzymatic hydrolysis of the scales.

The rats fed the casein diet lost, gained, lost, and gained weight (fig. 1). The weight gains that occurred after the weight losses were due to an increase in food made available according to the "paired" method of feeding, since the rats fed the diet containing hydrolysate as a source of protein soon died and were no longer the group that limited food intake. The result of more food being made available to the rats fed the diet containing the raw scales is also evident by the decreasing rate of weight loss for this group (fig. 1). The most pronounced effect of increased food consumption was with the group fed casein.

In the second rat-feeding study, the nutritive value was determined of diets containing fish-meal protein alone and in combination with fish-scale protein. This was done to determine if a possible solution to the fish-scale disposal problem might be found in including them in the production of fish meal.

Table 2 - Periodic Mean Grams Gain in Weight of Groups of Rats Fed a Diet Containing 10 Percent Protein from Fish Meal, and Diets Containing 10 Percent of the Fish-Meal Protein Replaced by Protein from Ocean Perch or Herring Scales

Time on Experiment	Diet Designation		
	Fish Meal	Fish Meal-Ocean Perch Scales	Fish Meal-Herring Scales
Days	(Grams)		
4	5.7	4.7	4.2
11	37.4	36.1	36.9
13	40.3	39.8	39.1
18	53.9	51.7	52.8
32	88.1	85.7	86.6
39	103.7	105.7	102.1
42	108.4	107.4	105.8

Three groups of eight albino post-weaning rats each were used for this test. All groups were fed similar, isocaloric, and nutritionally-complete diets, with the exception of the source of protein. One group was fed a diet containing a total of 10-percent protein from fish meal as the sole source of dietary protein. The two other groups were fed diets in which 10 percent of this fish-meal protein was replaced by an equal amount of protein from raw ground ocean perch or herring scales.

Scale hydrolysates were not investigated in this study, since the previous study indicated that they were not as efficient a source of protein as are the raw scales. The herring (Clupea harengus) scales were compared with ocean perch scales, since they were readily available and would provide additional data on the nutritive value of fish-scale protein. The fish meal and herring scales contained 60 and 70 percent crude protein (N x 6.25), respectively. The feeding study lasted 6 weeks.

A statistical analysis of the data in table 2 indicates that the growth responses of the group of rats fed the various diets were similar. Hence, under the conditions of this experiment, it can be concluded that diets, otherwise nutritionally complete but containing either ocean perch-scale or herring-scale protein in replacement of 10-percent fish-meal protein, are equal in nutritive value to a similar diet containing protein from fish meal alone when both are incorporated at a level of 10-percent protein in the diet.

These results necessitated an investigation of the nutritive value of similar diets containing a higher percentage of the dietary protein supplied from fish scales in place of equal amounts of fish-meal protein. Thus, the third test included a diet containing 9-percent protein from fish meal as the only source of dietary protein and two diets in which 30 percent of this fish-meal protein was replaced by protein from the perch and herring scales, respectively. Six post-weaning albino rats were allotted to the groups fed the three diets. The test lasted 6 weeks.

Table 3 - Periodic Mean Grams Gain in Weight of Groups of Rats Fed a Diet Containing 9-Percent Protein from Fish Meal, and Diets Containing 30 Percent of the Fish Meal Protein Replaced by Protein from Ocean Perch or Herring Scales

Time on Experiment	Diet Designation		
	Fish Meal	Fish Meal-Ocean Perch Scales	Fish Meal-Herring Scales
Days	(Grams)		
9	14.1	8.3	10.7
14	34.4	24.0	27.2
21	57.9	45.3	49.3
26	63.2	51.7	55.5
35	79.9	68.0	71.2
37	83.6	68.8	73.5
42	95.9	80.3	86.0

The data in table 3 indicate that the gain in weight of the group of rats fed the diet with fish-meal protein was not significantly different statistically from that of the group fed the diet containing herring scales as 30 percent of the dietary protein. The gain in weight of the group of rats fed the diet containing 30 percent of the protein from perch scales, however, was significantly different statistically from that of the group fed the fish-meal diet. The data therefore indicate that a diet otherwise nutritionally complete but containing herring-scale protein in replacement of 30 percent fish-meal protein is equal in nutritive value to a diet containing protein from fish meal alone when both are incorporated at a level of 9-percent protein in the diet. A diet containing ocean perch-scale protein in replacement of a similar amount of fish-meal protein, however, is poorer in nutritive value.

SUMMARY AND CONCLUSIONS

Three rat-feeding studies were conducted according to a method developed by Mitchell and Beadles (1930). The first test included as sources of protein the nitrogen compounds in raw ocean perch scales, a hydrolysate from these scales, and casein. The second and third tests included the protein from fish meal, and various combinations of fish meal and perch or herring scales. Under the conditions of the experimental procedure described herein, the data from this study indicate the following:

1. Young rats do not grow or even live when fed raw ground ocean perch scales or a pepsin hydrolysate of these scales as the sole source of protein at a 9-percent level in an otherwise nutritionally-adequate diet. The nutritive value of the ground-scale protein is somewhat better, however, than is that of the hydrolyzed-scale protein.

2. Diets, otherwise nutritionally complete but containing herring-scale protein in replacement of up to 30-percent fish-meal protein, are equal in nutritive value to a similar diet containing protein from fish meal alone when both are incorporated at a level of 10-percent protein in the diet.

3. Similar diets containing ocean perch-scale protein in replacement of 10-percent fish-meal protein are equal, but 30-percent replacement is poorer in nutritive value than is a diet containing protein from fish meal alone when both are incorporated at a level of 9-percent protein in the diet.

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RAT BIOASSAY OF UNIDENTIFIED GROWTH FACTORS IN POLLOCK FISH SCALES

By Donald G. Snyder*

ABSTRACT

Data are presented that indicate the presence of fair amounts of unknown growth factors in pollock fish scales when fed to rats in a special diet containing a thyroid stress factor. Thus, in addition to earlier feedings, further evidence is presented to suggest that fish scales may have value as a feed supplement in the diets of farm animals.

The problem of disposing of waste fish scales at filleting plants has stimulated an investigation of the value of the scales as a supplemental source of protein in the diets of farm animals. As an initial study in this investigation, Snyder and Nilson (1957) conducted rat feeding tests to compare (1) the nutritive value for growth, (2) the "biological value" for maintenance, and (3) the digestibility of pollock-fish-scale (PFS) protein and a protein supplement consisting of 3 parts casein and 1 part lactalbumin (CL).

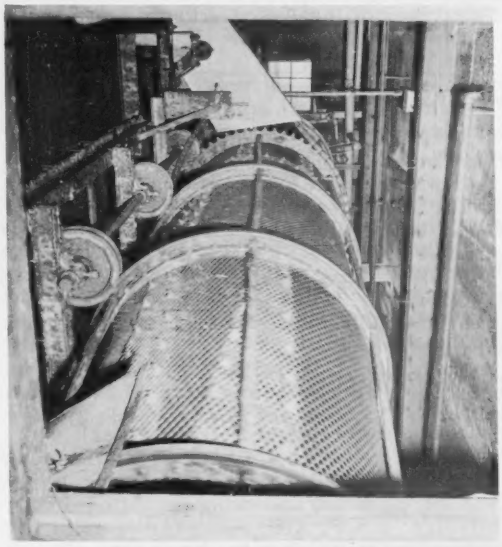

Fig. 1 - During commercial operations, fish scales generally are collected from expanded metal cylindrical automatic scalers.

The data from these studies indicate that PFS protein is digested as well as is the protein from CL but is utilized about 30 percent less efficiently. The data also indicate that young rats do not live when fed a diet containing 9 percent protein from only the protein of PFS. The protein from PFS can be utilized by the rats, however, when supplemented with CL protein in the diet. Increased utilization of PFS protein, in combination with stepwise higher levels of CL protein, indicates that no toxic substance per se for growing rats are present in the scales.

The nutritional inadequacy of PFS protein alone and the increased utilization of PFS protein in combination with stepwise higher levels of CL protein were interpreted as likely to be due to a deficiency and/or imbalance of specific nitrogen nutrients in PFS. Data in support of this interpretation were obtained in a further study on the amino acid composition of the protein of PFS (Snyder 1958). These data indicate that the protein of PFS is probably a scleroprotein of the collagen type, which contains high levels of glycine and low levels of many of the other amino acids. The data also indicate that the scales contain no unusual kinds or quantities of inorganic constituents that might cause biological injury when fed to animals.

The present study provides data that indicate the presence of fair amounts of unknown growth factor(s) for rats in the pollock fish scales. A qualitative estimate is given, since it has not been possible with the present bioassay methods to give a quantitative value.

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MATERIAL

The pollock fish scales were furnished by the staff of the Bureau's Fishery Technological Laboratory, East Boston, Mass. Pollock (Pollachius virens) were scaled by hand. The scales were washed thoroughly with water, drained, and spread in pans to dry in an oven at 100° C. The scales then were shipped to this laboratory, where they were ground, as finely as possible, in a Hobart coffee grinder.

No great variation was found in the moisture, protein (N x 6.25), fat and ash of representative samples of scales from the various lots. The mean and ranges of moisture content for four lots of scales were 4.4 and 1.0-6.9 percent respectively; of protein content for 11 lots were 59.5 and 56.6-62.5 percent; of fat content for four lots were 0.004 and 0.0-1.0 percent; and of ash content for five lots were 38.9 and 36.1-43.1 percent. The methods of analyses of the Association of Official Agricultural Chemists (1955) were used.

A representative sample of ground scales was chosen randomly from one of the lots received at this laboratory for use in the present study. The means of three analyses each of this sample of scales on the moisture-free basis were 60.1 percent for protein and 39.4 percent for ash.

No significant difference was found between the nutritive value of the scale protein from the lot of scales from which this sample was obtained and that of the various other lots of scales. It can be concluded, therefore, that the sample from this lot of scales was representative of the scales of pollock in general. The small differences in moisture, protein, fat, and ash contents found among the various lots of scales probably can be attributed to the nutritional status and age of the fish from which the scales were collected (Nishihara 1954).

EXPERIMENTAL AND RESULTS

The method used in this study was that of Emerson and Folkers (1951), with modifications. Post-weaning, black-hooded male and female rats were allotted to the bioassay at initial weights of 51 to 53 grams and 48 to 51 grams, respectively. During a 28-day depletion period, the rats were fed the following depletion diet in parts per 100: soybean meal, 60; salt mixture, U.S.P. XIV, No. 2 for vitamin A bioassay, 4; dextrose, 24; Crisco, 10; and cod liver oil, 2 parts by weight. To every 100 grams of this basal diet was added 0.075 grams of the following vitamin mixture: thiamine HCl, 1; riboflavin, 2; pyridoxine, 1; calcium pantathenate, 10; nicotinamide, 10; inositol, 5; para-aminobenzoic acid, 30; biotin, 0.05; folic acid, 0.2; menadione, 14.2; ascorbic acid, 2; and vitamin B_{12}, 0.01 parts by weight. In addition, 0.35 grams of choline chloride, 0.015 grams of alpha tocopherol, and 0.25 grams of thyroid powder were added. The thyroid powder was added as a stress factor to increase the demand of the rat for growth factors and, thereby, permit more sensitive detection.

At the end of the depletion period, the male and the female rats were separated as to sex, randomly allotted into groups of three rats each and fed the following four test diets (table 1) during a repletion period of 14 days: (1) depletion diet; (2) CP-50, 10 percent; (3) PFS, 5 percent; and (4) PFS, 10 percent. The "depletion diet" was the one given above. It contained no test material. The "CP-50, 10 percent" included 10 percent by weight--at the expense of soybean meal--of a sample of commercial menhaden meal of known origin that has been used at the College Park Laboratory for several years as a reference sample for the bioassay of unknown growth factors present in fish meal. Meal CP-50 contains a fair amount of unknown growth factors. The diet "PFS, 5 percent" and the diet "PFS, 10 percent" included 5 and 10 percent by weight of pollock fish scales at the expense of soybean meal.

The rats were housed individually in wire screen cages fitted on wire mesh floors. The temperature of the room was maintained at 80° F. The rats were supplied with food and water ad libitum, and weekly records were taken of live weight and consumption of food.

The mean actual gains in weight were 10.7, 21.3, 19.0 and 31.0 grams (table 1) for the male group fed the following four respective diets: (1) depletion diet; (2) CP-50, 10 percent; (3) PFS, 5 percent; and (4) PFS, 10 percent. For the female groups fed the same diets, the mean actual gains in weight were 7.0, 18.7, 16.0, and 23.7 grams, respectively. In general, the increased gains in actual weight of the male and the female groups fed diets containing meal CP-50 and PFS compared to the male and female groups fed the depletion diet indicate the presence of fair amounts of unknown growth factors in PFS. This interpretation appears valid, since meal CP-50 is considered to contain fair amounts of unknown growth factors. Interpretations to determine amounts of unknown growth factors present in meal CP-50 and PFS obtained by comparing difference in actual mean gains of the various groups fed the different diets, however, are limited, owing to the varying amounts of diet consumed by rats in different groups and to the varying initial weights of the rats at the start of the repletion period of feeding.

Table 1 - Actual and Estimated Mean Gains in Weight for Rats in Bioassay of Unknown Growth Factors in Pollock Fish Scales

Diet Designation	Actual Mean Gain		Estimated Mean Gain		Difference Between Actual and Estimated Mean Gain	
	Male	Female	Male	Female	Male	Female
	(Grams)					
Depletion diet	10.7	7.0	14.6	8.5	-3.9	-1.5
CP-50, 10 percent	21.3	18.7	18.6	18.8	2.7	-0.1
PFS, 5 percent	19.0	16.0	22.1	22.1	-3.1	-6.1
PFS, 10 percent	31.0	23.7	28.4	19.7	2.6	4.0

Note: CP-50 is a menhaden meal containing fair amounts of unknown growth factors. PFS is an abbreviation for pollock fish scales. Values in percent refer to supplementations by weight of the test material in place of a like amount of soybean meal contained in the depletion diet.

To eliminate variability of food consumption and weight, the estimated gains were computed from a multiple regression analysis that included initial weights of the rats in each group at the start of the repletion period, food consumed, and gains in weight during the repletion period (Snedecor 1956). Probably the most valid interpretation of the data to determine amounts of unknown growth factors present in PFS, then, is to compare the actual mean gains with these estimated mean gains thus computed of each of the male and the female groups fed the same level of supplementation (table 1). The difference between actual and estimated mean gain was -3.9, 2.7, -3.1, and 2.6 when the male groups were fed the depletion diet; CP-50, 10 percent; PFS, 5 percent; and PFS, 10 percent, respectively. The difference between actual and estimated mean gain was -1.5, -0.1, -6.1, and 4.0 when the female groups were fed these same diets, respectively. These data indicate that for rats, and under these conditions of testing, a diet containing 10 percent PFS contains fair amounts of unknown growth factors but that one containing 5 percent PFS contains insufficient amounts. No reasons are obvious for the large difference (-6.1) between the actual and estimated mean gain of the female groups fed the diet "PFS, 5 percent." These data would suggest that although PFS contains unknown growth factors, sufficient quantities must be included in the diet to insure the effect of these factors on growth.

CONCLUSIONS

During the past few years, the fishing industry has had the increasingly difficult problem of annually disposing of thousands of tons of fish scales because filleted fish now have replaced whole fish in volume of sales. Harbors that are close to plants normally provide an inexpensive area for the disposal of scales, but unless tidal flows are strong, pollution may result. Various attempts to utilize the scales have been unsuccessful.

Recently, however, as part of a general study to determine whether scales may have value as a supplemental source of protein in the diets of farm animals, Snyder and Nilson (1957) found that pollock-fish-scale (PFS) protein is well digested by rats and can be utilized as a limited source of protein when supplemented with casein-lactalbumin protein. In this paper are presented data that indicate the presence of fair amounts of unknown growth factors in PFS.

It must be pointed out, however, that unknown growth factors in PFS are indicated here only under the conditions of this particular experiment: that is, when rats are fed a special diet containing a thyroid stress factor.

The problem remains to determine (1) the effect of unknown growth factors when diets containing no stress factors are fed and (2) the ability of other species of animals to utilize these growth factors.

ACKNOWLEDGEMENTS

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PROCESS TRANSFORMS FISH-LIVER OIL INTO STABILIZED DRY VITAMIN A

A unique process which transforms fish-liver oil into a stabilized dry Vitamin A has been developed by a Tokyo, Japan, firm. The process involves coating minute particles of the oil with selected rigid materials so that the Vitamin A content is not destroyed by contact with the air or with other materials. The stabilized potency of the vitamin and economical prices are expected to result in great advantages to consumers, as the process is utilized in pharmaceuticals and enriching food (Western Fisheries, April 1958).

Editorial Assistant--Ruth V. Keefe Illustrator--Gustaf T. Sundstrom

Compositors--Jean Zalevsky and Vera Eggleston

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PROXIMATE COMPOSITION OF GULF OF MEXICO INDUSTRIAL FISH

Part 1 - Winter and Spring of 1958 Studies

By Mary H. Thompson*

ABSTRACT

The protein, oil, ash, and moisture contents of 11 species of industrial fish commonly taken in the winter and spring in the Gulf area are reported. Included also are length and weight data.

INTRODUCTION

The fish-meal, cat-food, and other animal-food industries have a need for data on the protein, oil, ash, and moisture contents (proximate composition) of the various species of industrial fish. Several of the newly-established industries on the Gulf Coast that use industrial fish need such information. Unfortunately, with the exception of the analyses of Lee, Nilson, and Clegg (1955), which were made primarily in connection with a thiaminase study, little information is available on the proximate analyses of the various species of industrial fish taken in the Gulf area. The present project was initiated to obtain the required knowledge.

The protein, oil, ash, and moisture contents of fish vary from individual to individual, from species to species (even though closely related), from geographical area to geographical area, from season to season, and from year to year. (Mangan, Geo. et al 1958; Sanford 1958; Stansby 1953 and 1954; and Thurston et al 1958.) The oil content and moisture content tend to vary in the greatest degree. In most species, the oil content falls to a low level in the winter, rising to a peak in the late spring, summer, or early fall.

It is thus evident that a study of the proximate composition of the industrial fish in the Gulf area must be extensive and must cover a considerable period of

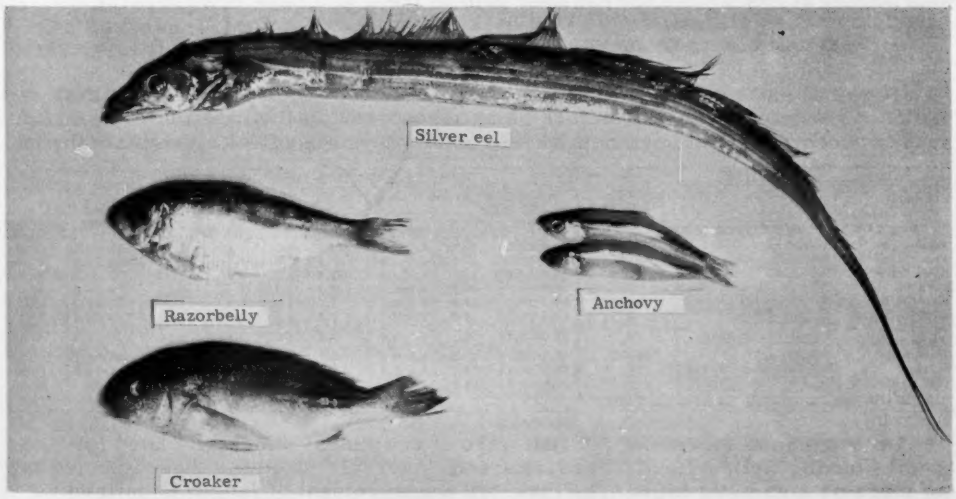

Fig. 1 - Four of the most common species of industrial fish caught in the Gulf of Mexico on a year-round basis.

time if it is to furnish a complete picture of the nature of these variances. The in-

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dustry, however, has an immediate need for the data. Results are therefore being published as they are accumulated, even though it is recognized that the data in any one report will necessarily be incomplete.

The approach used in this study is to determine the proximate analyses of the common industrial species season by season. For this purpose, the months in the various seasons have been designated as follows: winter--December, January, and February; spring--March, April, and May; summer--June, July, and August; and fall--September, October, and November. This division of months has been chosen as most closely following the meteorological conditions in the area.

SAMPLES

All of the samples of fish for the analyses reported in this paper (with the exception of the spots and butterfish caught in the spring) were taken by the U. S. Bureau of Commercial Fisheries exploratory fishing vessel Oregon during cruises in the North Gulf in the winter and spring of 1958. These fish, including the spots and butterfish caught in the winter, were placed in 5-pound waxed cartons and frozen aboard the Oregon immediately after capture. They were kept frozen until the time of analysis. The spring-caught spots and butterfish were obtained from fishing vessels landing at Pascagoula and had been held in ice 2 to 3 days prior to being analyzed.

Table 1 - Location of Catch and Physical Measurements of Industrial Fish Commonly Caught in the Winter

Common Name	Scientific Name	Caught (1958)	Location	No. of Fish in Each Sample	Type of Measurement	Length		Weight	
						Range	Average	Range	Average
						(Centimeters)		(Grams)	
Anchovies	Anchoa sp.	Feb.	Miss. Sound	72-93	Forktail	5.0- 7.0	6.0	1.4- 4.0	2.5
Anchovies	Anchoa hepsetus	Feb.	Miss. Sound	12-13	Forktail	10.9-12.9	11.7	13.3- 25.1	19.0
Butterfish	Poronotus triacanthus	Feb.	Miss. Sound	2	Forktail	12.5-16.8	14.7	53.5-100.0	75.4
Croaker	Micropogon undulatus	Feb.	Miss. Sound	2	Forktail	18.6-21.1	19.8	61.0-116.0	77.2
Razorbellies	Harengula pensacolae	Feb.	Miss. Sound	6	Over-all	13.1-15.9	14.8	21.0- 42.5	35.4
Round herring	Etrumeus teres	Feb.	Miss. Sound	3	Forktail	14.5-17.1	15.6	35.5- 59.0	47.0
Silver eels (Cutlassfish)	Trichiurus lepturus	Feb.	Miss. Sound	4	Over-all	36.7-45.8	42.8	25.4- 48.6	37.6
Silversides	Menidia sp.	Feb.	Miss. Sound	26-28	Forktail	7.5- 9.8	8.7	4.4- 9.2	6.3
Spots	Leiostomus xanthurus	Feb.	Miss. Sound	2	Forktail	18.8-20.2	19.5	81.4- 90.2	85.8
Thread herring	Opisthonema oglinum	Feb.	Miss. Sound	4	Forktail	13.4-15.4	14.3	36.8- 52.8	43.8

Note: Data on the proximate composition of these fish are given in table 2.

PHYSICAL MEASUREMENTS

Physical measurements of the fish were obtained prior to analysis. Fish that had been frozen were thawed before being measured. In the case of very small fish, such as anchovies and silversides, a random sample was used as a criterion of the lot.

Table 2 - Proximate Composition of Industrial Fish Commonly Caught in the Winter

Common Name	Scientific Name	No. of Fish in Each Sample	Protein		Oil		Ash		Moisture	
			Range	Average	Range	Average	Range	Average	Range	Average
						(Percent)				
Anchovies	Anchoa sp.	72-93	16.3-16.7	16.4	3.3-3.9	3.5	3.33-3.53	3.45	75.6-76.1	75.9
Anchovies	Anchoa hepsetus	12-13	16.3-17.9	17.3	2.5-2.8	2.6	3.44-3.76	3.53	75.3-76.3	75.7
Butterfish	Poronotus triacanthus	2	14.6-16.2	15.1	1.6-3.4	2.2	2.56-3.26	2.82	77.1-80.3	79.3
Croaker	Micropogon undulatus	2	14.5-15.8	15.2	1.6-2.8	2.2	4.59-6.42	5.98	75.9-78.5	77.2
Razorbellies	Harengula pensacolae	6	18.2-19.7	18.9	6.5-9.3	7.7	6.1 -8.1	7.1	66.2-68.0	67.1
Round herring	Etrumeus teres	3	18.3-19.3	18.9	2.2-2.7	2.5	3.39-4.09	3.82	73.6-74.1	73.8
Silver eels (Cutlassfish)	Trichiurus lepturus	4	17.9-18.3	18.1	4.1-4.4	4.3	2.63-3.23	2.96	75.0-75.8	75.4
Silversides	Menidia sp.	26-28	17.2-17.6	17.4	5.6-6.1	5.9	7.74-8.84	8.23	67.1-68.1	67.5
Spots	Leiostomus xanthurus	2	13.8-14.2	14.1	5.5-5.5	5.5	3.96-4.21	4.09	76.4-76.5	76.5
Thread herring	Opisthonema oglinum	4	18.5-19.2	18.9	7.8-8.3	8.1	2.57-3.66	3.24	68.4-70.1	69.3

Note: Data on the physical measurements of these fish are given in table 1.

Length measurements of the fish were of two kinds: "forktail" used for those species having well-defined forked tails; and "over-all" used for those species having more or less blunt tails. The fork-tail measurement of length is defined as being from the tip of the mouth to the apex of the angle formed by the two sides of the tail. The over-all measurement was from the tip of the mouth to the farthest end of the tail.

Measurements of weight of the fish were made by means of a double-beam pan balance.

The data obtained on the physical measurements of the fish are given in tables 1 and 3.

Table 3 - Location of Catch and Physical Measurements of Industrial Fish Commonly Caught in the Spring

Common Name	Scientific Name	Caught 1958	Location	No. of Fish in Each Sample	Type of Measurement	Length		Weight	
						Range	Average	Range	Average
						(Centimeters)		(Grams)	
Anchovies	Anchoa hepsetus	March	North Florida	13-14	Forktail	9.5-11.7	10.8	10.6- 20.6	15.0
Butterfish	Poronotus triacanthus	May	Chandeleur Sd.	37-41	Forktail	5.8- 9.7	6.7	3.8- 16.3	6.0
Shad	Pomolobus chrysochloris	March	North Florida	2	Forktail	18.6-21.7	20.0	82.8-128.2	106.7
Spots	Leiostomus xanthurus	May	Grand Isle	2	Forktail	19.0-21.0	20.0	109.8-143.5	125.0
Thread herring	Opisthonema oglinum	March	North Florida	2	Forktail	17.0-19.6	18.3	77.2-115.5	95.6

Note: Data on the proximate composition of these fish are given in table 4.

PROXIMATE COMPOSITION

After the fish were measured, they were washed and drained. From each lot 4 to 6 samples of fish, with an aggregate weight of between 150 and 200 grams (5.3-7.1 ounces) of fish per sample, were selected at random, and each of these samples was ground separately in a General Food Grinder, Model H. Each sample was reground twice. Portions for analysis then were taken from each ground sample.

The methods of proximate analyses used were contained in an unpublished manuscript, Current Proximate Analysis Procedures, from the Bureau's Fishery Technological Laboratory, Seattle, Wash. These methods were the Official Methods of Analysis of the Association of Official Agricultural Chemists (1955) modified as follows:

1. Moisture: 20 grams of white sand was measured into aluminum dishes, replacing asbestos fiber in gooch crucibles.

2. Ash: Vycor crucibles replaced platinum ones; moistening the ash with water and re-ashing was not deemed necessary.

3. Protein: Selenium granules replaced HgO or metallic Hg as the catalyst; therefore sulfide or thiosulfate solution was not needed to precipitate the Hg.

The data obtained on the proximate composition of the fish are given in tables 2 and 4. The number of samples and the number of fish in each sample was neces-

Table 4 - Proximate Composition of Industrial Fish Commonly Caught in the Spring

Common Name	Scientific Name	No. of Fish in Each Sample	Protein		Oil		Ash		Moisture	
			Range	Average	Range	Average	Range	Average	Range	Average
			(Percent)							
Anchovies	Anchoa hepsetus	13-14	16.9-17.1	17.0	2.9-3.2	3.0	3.21-3.43	3.36	75.0-75.9	75.6
Butterfish	Poronotus triacanthus	37-41	14.1-15.0	14.4	2.1-2.5	2.3	2.85-3.31	3.06	80.5-80.9	80.7
Shad	Pomolobus chrysochloris	2	19.4-19.6	19.6	2.0-4.4	3.2	2.01-3.23	2.52	72.7-74.9	73.6
Spots	Leiostomus xanthurus	2	15.5-16.2	15.8	16.0-16.8	16.5	3.27-4.17	3.74	63.3-64.4	63.9
Thread herring	Opisthonema oglinum	2	19.4-19.4	19.4	4.8-5.4	5.0	4.46-4.94	4.59	69.9-70.8	70.4

Note: Data on the physical measurements of these fish are given in table 3.

sarily limited in this initial study. A discussion of the data is therefore deferred until additional observations can be reported.

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CALIFORNIA EXPERIMENTS WITH THE PLANTING OF FRESH-WATER SHRIMP FROM FLORIDA

A trial planting of fresh-water shrimp from Florida has been made in the Colorado River near Lake Havasu by the California Department of Fish and Game.

The Department is trying to expand the food supply of sport fish in the river, which now lacks invertebrate food organisms.

This fresh-water shrimp (Palaemonetes paludosus) is considered a boon to sport fish in Florida and the Department has hopes it will prove to be of equal benefit to Colorado River fish.

Little is known of the life history of this shrimp. It probably breeds once a year, in the spring, and grows to a maximum size of about two inches. It does not exist in trout waters. It poses no problem of competition with sport fish for food since it does not feed on insects. It converts detritus algae directly into food and becomes food itself for such species as catfish, bass, crappie and bluegills.

The first shipment--225 shrimp--was merely for testing purposes to determine whether the animals would survive the long airplane flight from Florida and the automobile trip across the desert to the Parker Dam area. They survived both in good shape.

Planted in a pond near Parker Dam, they will be observed by the Department to determine how well they adapt themselves to their new environment and whether they will reproduce there. The Department has asked for another 1,000 for testing purposes.

PROXIMATE COMPOSITION OF GULF OF MEXICO INDUSTRIAL FISH

Part 2 - Summer of 1958 Studies

By Mary H. Thompson*

ABSTRACT

Tables giving the length and weight of 15 species of industrial fish and the protein, oil, ash, and moisture contents of these fish are included in this report. These species are representative of the ones most commonly found in the Gulf of Mexico during the summer season.

INTRODUCTION

Continuing the work begun in the winter of 1958 on the length, weight, and proximate composition of various species of industrial fish caught in the Gulf of Mexico, the same type of data now has been obtained for 15 species commonly found during the summer months (June, July, and August) in this region. Protein, oil, ash, and moisture contents, and also length and weight data of these fish thus far have been determined for the winter, spring, and summer seasons.

Some of these constituents--particularly oil and moisture--tend to change markedly in most species from season to season. It is necessary, therefore, not only that these data be known for each species, but that they also be known for each species in each season.

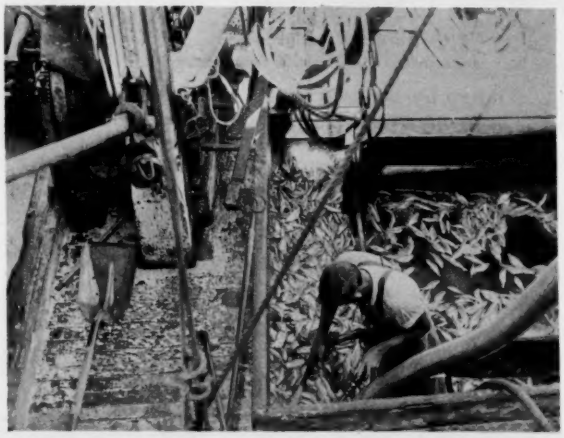

Fig. 1 - Industrial fish being unloaded at a Pascagoula, Miss., dock with a "fish pump."

SAMPLES

All of the samples were industrial fish landed in Pascagoula. The fish had been well iced from 1 to 3 days prior to being collected by laboratory personnel. Upon receipt, the fish were frozen and stored at -20° C. (-4° F.) until analyzed.

Table 1 - Location of Catch and Physical Measurements of Industrial Fish Commonly Caught in the Summer

Common Name	Scientific Name	Caught (1958)	Location	No. of Fish in Each Sample	Type of Measurement	Length		Weight	
						Range	Average	Range	Average
						(Centimeters)		(Grams)	
Anchovies	Anchoa hepsetus	June	Breton Island	14-16	Forktail	10.1-11.8	10.8	8.4- 19.4	12.3
Bumper	Chloroscombrus chrysurus	July	Cat Island	2	Forktail	15.4-17.2	16.5	50.7- 71.1	61.0
Butterfish	Poronotus triacanthus	June	Grand Isle	2-4	Forktail	9.7-15.0	11.6	19.0- 90.9	42.2
Croaker (June)	Micropogon undulatus	June	Grand Isle	2	Over-all	17.9-21.0	19.4	65.6-111.3	88.1
Croaker (July)	Micropogon undulatus	July	Cat Island	2	Over-all	20.2-26.0	22.2	81.4-181.7	118.5
Hardheads	Galeichthys felis	June	Grand Isle	1	Forktail	22.1-24.2	23.3	149.8-304.2	182.6
Harvestfish	Peprilis sp.	July	Cat Isle	1-2	Forktail	13.0-16.2	14.8	83.9-129.9	111.2
Menhaden	Brevoortia sp.	Aug.	Chandeleur Island	1-2	Forktail	15.9-19.5	17.4	82.2-161.4	110.3
Razorbellies	Harengula pensacolae	June	Breton Island	4	Forktail	11.0-15.0	12.9	22.8- 60.1	37.5
Silver eels (cutlassfish)	Trichiurus lepturus	June	Grand Isle	3	Over-all	38.3-54.7	48.5	26.4- 99.8	62.5
Spots	Leiostomus xanthurus	July	Cat Island	2	Forktail	17.7-19.5	18.5	84.7-112.3	98.3
Star drum	Stellifer lanceolatus	June	Horn Island	9-10	Over-all	10.9-13.9	12.5	10.8- 29.4	20.2
Threadfin	Polynemus sp.	July	Cat Island	8	Forktail	10.4-12.2	11.3	15.9- 27.9	20.7
Thread herring	Opisthonema oglinum	Aug.	Cat Island	1-2	Forktail	18.1-18.8	18.5	89.0-109.9	100.1
White trout	Cynoscion sp.	July	Cat Island	1-2	Over-all	17.6-29.9	22.2	55.1-128.0	87.8

Note: Data on the proximate analyses of these fish are found in table 2.

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PHYSICAL MEASUREMENTS

Measurements of length and weight were obtained on the fish after they were thawed.

The measurements of length were of two types. Those species with a well-defined forked tail were measured from the tip of the mouth to the apex of the angle

Table 2 - Proximate Composition of Industrial Fish Commonly Obtained in the Summer

Common Name	Scientific Name	No. of Fish in Each Sample	Protein		Oil		Ash		Moisture	
			Range	Average	Range	Average	Range	Average	Range	Average
			(Percent)							
Anchovies	Anchoa hepsetus	14-16	17.1-17.3	17.2	2.2- 3.3	2.6	3.20-3.44	3.29	76.9-77.6	77.3
Bumper	Chloroscombrus chrysurus	2	18.6-18.9	18.7	4.8- 6.9	6.0	3.42-5.15	4.22	70.3-73.0	71.3
Butterfish	Poronotus triacanthus	2-4	15.0-15.9	15.6	4.9- 7.4	6.2	1.49-3.12	2.36	74.2-78.5	76.0
Croaker (June)	Micropogon undulatus	2	15.6-16.3	15.9	6.3-10.0	8.6	4.29-5.60	4.85	67.1-73.0	69.9
Croaker (July)	Micropogon undulatus	2	16.4-16.9	16.7	2.8- 4.5	3.6	2.37-3.41	3.05	75.0-77.8	76.0
Hardheads	Galeichthys felis	1	16.6-17.5	17.0	6.1- 7.2	6.7	3.70-5.06	4.14	70.5-72.1	71.0
Harvestfish	Peprilis sp.	1-2	16.1-16.8	16.4	4.8- 9.0	7.5	2.08-2.69	2.31	70.4-76.9	73.0
Menhaden	Brevoortia sp.	1-2	14.1-16.1	14.9	13.1-20.5	17.8	3.30-4.08	3.66	60.5-66.8	63.3
Razorbellies	Harengula pensacolae	4	17.1-18.9	18.4	4.4- 5.4	5.0	3.64-5.61	4.81	70.8-73.4	71.8
Silver eels (cutlassfish)	Trichiurus lepturus	3	15.9-16.6	16.3	2.3- 2.8	2.6	1.90-2.91	2.26	77.2-78.8	77.9
Spots	Leiostomus xanthurus	2	14.8-15.6	15.2	11.6-13.7	12.9	2.85-3.78	3.39	67.1-70.4	68.1
Star drum	Stellifer lanceolatus	9-10	14.4-15.2	15.0	3.4- 4.0	3.8	3.89-4.28	4.11	75.1-76.9	76.3
Threadfin	Polynemus sp.	8	16.9-17.6	17.3	1.6- 2.1	1.8	3.52-4.15	3.98	76.2-77.3	76.6
Thread herring	Opisthonema oglinum	1-2	18.3-18.8	18.6	3.2- 3.9	3.5	2.76-4.19	3.27	73.4-75.2	74.4
White trout	Cynoscion sp.	1-2	17.0-18.1	17.5	3.3- 6.3	5.0	2.56-3.76	3.09	73.1-76.5	74.3

Note: Data on the physical measurements of these fish are given in table 1.

formed by the two sides of the tail. This measurement is referred to as "forktail." Those species with a more-or-less blunt tail were measured from the tip of the mouth to the farthest end of the tail. This measurement is referred to as "over-all."

The measurements of weight were made by means of a double-beam pan balance.

The data are given in table 1.

PROXIMATE COMPOSITION

Details of the methods of proximate analysis used were reported in the first paper in this series (Thompson 1958).

Results of the present analyses are shown in table 2, and seasonal changes in oil and moisture contents are shown in table 3. Changes in protein and ash contents

Table 3 - Seasonal Changes in Oil and Moisture Contents

Common Name	Scientific Name	Change in Oil Content			Change in Moisture Content		
		Winter to Spring	Spring to Summer	Winter to Summer	Winter to Spring	Spring to Summer	Winter to Summer
		(Percent)					
Anchovies	Anchoa hepsetus	+ 0.4	- 0.4	0.0	- 1.0	+ 1.7	+ 1.6
Butterfish	Poronotus triacanthus	+ 0.1	+ 3.9	+ 4.0	+ 1.4	+ 4.7	- 3.3
Croaker 1/	Micropogon undulatus	+ 6.4	- 5.0	+ 1.4	- 7.3	+ 6.1	- 1.2
Razorbellies	Harengula pensacolae	-	-	- 2.7	-	-	+ 4.7
Silver eels (cutlassfish)	Trichiurus lepturus	-	-	- 1.7	-	-	+ 2.5
Spots	Leiostomus xanthurus	+11.0	- 3.6	+ 7.4	-12.6	+ 4.2	- 8.4
Thread herring	Opisthonema oglinum	- 3.1	- 1.5	- 4.6	+ 1.1	+ 4.0	+ 5.1

1/ The time intervals for the croaker were as follows: winter to early summer, early summer to late summer, and winter to late summer.
Note: These estimates are based on only a few samples. Although they represent the best presently-available knowledge, further studies may change them markedly.

are not presented because they were relatively small. Discussion of the results will be deferred until the fish can be sampled more extensively.

To obtain a completely reliable estimate of the proximate composition of fish requires a large number of samples of each species, a large number of fish in each sample, and a sampling period covering several years (Stansby 1954). Unfortunately,

other than the findings of Lee, Nilson, and Clegg (1955) and of the present studies, the literature has little information of the proximate composition of Gulf of Mexico fish. The fish-meal and pet-food industries, however, need this information to guide their manufacturing operations. Even the relatively small amount of data available here should, therefore, be of help.

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FIDDLER CRAB

Fiddler crabs are cosmopolitan inhabitants of our marine and brackish water shores and therefore attract the curiosity of both layman and scientist.

Nearly 30 species of fiddler crabs are recognized along both coasts of North and Central America. The banks of almost every sluggish, brackish water display fiddler burrows from the fresh headwaters to the sea. Shallow muddy or sandy tidal flats often contain large populations of these animals. Salt-marsh areas may support the burrowing and feeding activities of several species within a suprisingly small area.

The fiddler's burrow is excavated above or within the tide marks. Burrowing depth appears to be greater in areas above the high tide line with some holes extending several feet beneath the surface. The digging of a burrow is a solitary effort on the part of its inhabitant and serves as its home for periods of from several hours to a week or more. Crabs normally leave their burrows during low tide to feed along the water's edge, but when the tide floods back most species return to the burrow and plug the entrance with a bit of mud. Very young crabs apparently do not burrow but run freely in and out of the holes occupied by adults.

Perhaps the most distinctive feature of the fiddler is the grotesque enlargement of one of the claws. This large claw identifies only the male and plays an important part in courtship behavior. During breeding season the color patterns of the upper parts of the body and claw of the males assume brilliant multicolored contrasts. At this time the male apparently abandons feeding and stands on tiptoe at the mouth of his burrow waving the large claw with a rhythmic beckoning motion. He may continue this activity for days before a female is attracted. The regular motion of the claw evidently has reminded many an imaginative naturalist of a violin virtuoso bowing his instrument.

The large claw is seldom, if ever, used in feeding. Fiddler crabs seem to feed on minute particles of organic debris and the tiny organisms that are associated with such material. This food is conveyed to the mouth parts in bits of mud which are picked up by the small claw. Structures around the mouth are covered with fine bristles that separate the edible material from the mud and leave the latter free to be expelled in tiny pellets.

The mating of fiddler crabs takes place in late May or early June in the Delaware area. The female deposits several thousand eggs in a protected spot beneath her abdomen where they are cemented to fine hairs on the appendages. Although she carries this egg mass out of the water, she regularly "washes" the eggs to prevent drying and to provide oxygen for the developing embryos. The eggs mature during the late summer and early fall when the larval forms or zoeas are hatched into the water.

The young resemble those of most other crabs although the larvae of only a few species of fiddler crabs have been identified. Fiddler crab larvae are free-floating members of the zooplankton until the following spring, by which time they have passed through at least one more developmental stage and have lost the ability to remain suspended in the water. Their general body form is now much like that of the adult, and the acquisition of protected gills and certain unique physiological mechanisms has prepared them for an amphibious life.

The fiddler crab plays a most interesting and integral part in the economy of our tidelands. The fisherman is generally familiar with their use as bait; they are popular dinner fare for herons, egrets, sandpipers, gulls, lizards, and raccoons; their planktonic larvae doubtlessly represent a major diet item for many species of fish; and the amount of nutrient material that the adults release from marshlands must be comparable to that freed by earthworms from tillable land. The contribution of this little animal to our welfare is not limited, however, to these items of local interest. The scientist is finding the fiddler an extremely valuable animal for physiological experimentation in research of direct medical value to man.

(Estuarine Bulletin, Autumn 1958, University of Delaware.)

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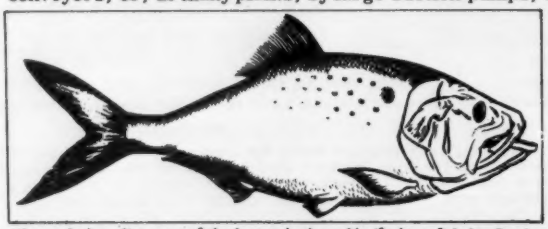
MENHADEN INDUSTRY--PAST AND PRESENT

Fishery Leaflet 412 (Menhaden Industry--Past and Present) describes the early history of the menhaden industry from its start in New England sometime prior to 1875, the role of the Federal Government in the development of this industry, a description of the menhaden, the early history of the menhaden oil industry, and a comparison of the early and modern menhaden plants, economic comparison of past (about 1875) and present-day (1950) plant operations, geographic shifts in the importance of menhaden fisheries, fishing methods, uses of menhaden--past and present, and the future of the menhaden industry. Since this Fishery Leaflet was published (June 1953), the menhaden have returned to New England waters and at the present time are of considerable economic importance to the port of Gloucester, Mass.

The menhaden industry has expanded considerably during recent years--the catch reached a record high of 2.1 billion pounds in 1956, plants and vessels have been modernized, demand and prices for both menhaden oil and meal have been excellent, and due to a vigorous program of research on the improvement of present and the development of new uses, the future appears bright for this industry.

The modern plant is mechanized to the ultimate degree. Fish are unloaded from the hold by conveyors, or, in many plants, by large suction pumps, onto conveyors which carry them through a weighing device and directly to the cookers or to temporary holding bins. The fish are then forced through long steam cookers in a continuous stream by screw conveyors, and, while hot, go directly to huge continuous screw presses.



The menhaden, alias porgy, fatback, mossbunker, old wife, bony-fish, hardhead, white-fish, bug-fish, chebog, alewife, and yellowtail shad--in short Brevoortia tyrannus--is similar in appearance to the herring, has a black spot just back of the head on each side, ranges in size from 5 to 8 inches, which make up most of the present catch, to a maximum of 18 inches.

In some plants the press liquors are still run off to settling tanks, a procedure not unlike the earliest methods. However, in most modern plants the fines are first filtered out on vibrating screens and the filtrate of liquor-and-oil mixture goes through two batteries of centrifuges. An almost dry, clear, yellow oil emerges from the second series of centrifuges. The water phase, called stickwater, contains considerable amounts of dissolved protein and vitamins but was ordinarily discarded. However, it is now concentrated to 50-percent solids in many plants to yield "condensed fish solubles." Most plants now have equipment of all types individually driven by electric motor rather than by steam power. This eliminates the maze of shafting and belts which is necessary for power transmission from a single central power unit.

The press cake is fed directly into large rotary, direct flame or steam driers where the wet material is reduced to "scrap" with a moisture content of six to ten percent. Most of the driers are now fired with fuel oil rather than coal, a change which results in a cleaner, more readily controlled operation. Some plants have cyclone separators to remove fine material from the exhaust gases.

The dried scrap is piled on the "scrap house" floor to cool before being bagged. In many plants, cooling is hastened by shoving the scrap into a conveyor that carries it up to the ceiling and then sifts it down to the floor in a fine shower. The ultimate in mechanical handling is reached by plants using small truck-tractors equipped with 'dozer blades for moving meal piles around the cooling floor.

In some plants the scrap is ground to meal, in others the unground scrap is shipped. In either case, the material is weighed into sacks automatically and the sacks are sewed by a special sack-sewing machine in modern plants. Another recent innovation in the menhaden industry is the use of pallettes and special fork-hoist trucks to load the sacked scrap or meal into trucks or freight cars.